

Search for a neutrino flux from LS I +61° 303 based on a time dependent model with IceCube

L. Demirörs^a, for the IceCube collaboration

^a*Laboratoire de Physique des Hautes Energies, EPFL, CH-1015 Lausanne, Switzerland*

Abstract

We present a search based on a time dependent neutrino flux prediction from the X-ray binary LS I +61° 303. Results from data taken with the 22 and 40 strings of IceCube are compatible with background fluctuations.

LS I +61° 303 is one of the most intensely studied galactic objects (c.f. [1]). Belonging to a group of objects termed gamma-ray loud X-ray binaries (GRLB), it consists of a massive central Be star orbited by a compact companion of unknown nature (neutron star or black hole). It shows variable emission from radio [2] to X-rays, e.g. [3], and has been detected at TeV energies [4, 5]. As yet, it is unclear if the observed broadband emission is caused mainly by hadronic or leptonic interactions. The observation of a neutrino flux would prove hadronic acceleration at the source.

In the model considered here [6, 7] neutrinos originate from interactions of high energy (HE) protons from the compact companion with the dense disk around the central star. For them to be observable, they have to be produced in a cone aligned with the line of sight. Since the HE protons will only be weakly deflected by the system's magnetic field, highest fluxes are expected when the companion is eclipsed by the stellar disk. During that phase the accompanying γ -ray emission from secondary e^\pm and π^0 decay is strongly suppressed due to the high density of soft photons and matter in the stellar disk. Therefore, the predicted neutrino flux does not positively correlate with the observed TeV photon flux.

Two parameters determine the width of the phase where neutrino emission can be observed: the inclination of the system's ecliptic with respect to the observer, and the disk size. Four configurations were chosen to cover scenarios where the companion is either a neutron star or black hole. To account for the unknown ac-

celeration mechanisms at the source, two simple power law neutrino spectra were chosen with spectral indices of $\Gamma = 1.5$ or 2, respectively.

The IceCube observatory is a one cubic kilometer neutrino telescope scheduled to be fully instrumented in 2011. The eight model predictions from above were tested with 22-string data taken in 2006–2007 [8]. Assuming their validity, the sensitivity of this search was increased in comparison to generic searches by down-scaling the background expectation. Event candidates were selected according to their distance to the source location, their estimated energy and their time in the LS I +61° 303 period. These search parameters were optimized to give the best sensitivity for a 5σ discovery in 90% of trials. The best model had four event candidates within the search parameters. The preliminary post-trial p-value was 5.61%. In a preliminary analysis on data taken with the 40-string configuration (2007–2008), no signal was seen.

This work is supported by the Swiss National Research Foundation (grant PP002–114800)

References

- [1] M. Massi, Introduction to Astrophysics of Microquasars (2005).
- [2] P. C. Gregory, *Astrophys. J.* 575 (2002) 472.
- [3] A. A. Abdo, et al., *Astrophys. J.* 701 (2009) L123–L128.
- [4] J. Albert, et al., *Astrophys. J.* 693 (2009) 303–310.
- [5] V. A. Acciari, et al., *Astrophys. J.* 700 (2) (2009) 1034.
- [6] A. Neronov, M. Ribordy, *Phys. Rev. D* 79 (4) (2009) 043013.
- [7] M. Chernyakova, A. Neronov, M. Ribordy, arXiv:0912.3821v1.
- [8] R. Abbasi, et al., *Astrophys. J.* 701 (2009) L47–L51.